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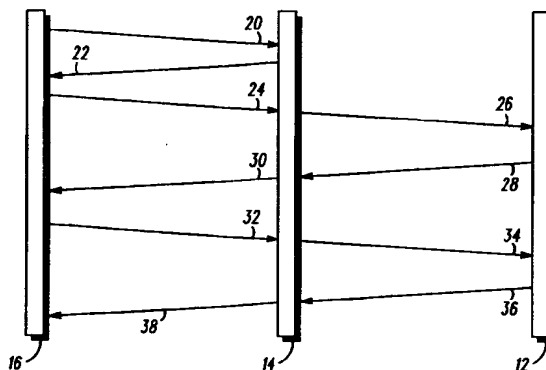
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(54) **Method for registering direct mode mobile stations in a trunking communications system.**

(57) A method as shown in FIG. 3 for registering a direct mode mobile station (16) with a system controller (12) of a trunked radio system by an independent gateway transceiver (14). The method includes registering the mobile station (16) with the system controller (12) of the trunked radio system by the gateway transceiver (14) using a third party registration scheme.

FIG. 3**BEST AVAILABLE COPY**

Field of the Invention

This invention relates in general to a communications system such as a trunked radio communications system, and more particularly to a method for registering a direct mode mobile station with the trunked radio communications system.

Background to the Invention

Trunked radio communications systems are well known in the art. In trunked radio communications systems, a plurality of subscribers share a predetermined number of communications resources. The resources are assigned to subscribers, or mobile stations, by a system controller of the trunked radio system. The system controller may be a central control station or distributed logic at various control stations.

In a trunked communications system, each of the trunked mobile stations is specially equipped with control circuitry to enable requesting and receiving a communications resource and to enable operating on the communications resource assigned by the system controller. Typically, before a trunked mobile station is able to request a communications resource from the system controller, the mobile station must first have registered with the trunked radio system. Registration allows a mobile station to be identified to the system controller and thereby be located by the system controller when needed. Registration is also an important part of security of the trunked radio system. The system controller is able to deny access to a communications resource for a mobile station if the mobile station is not properly registered on the trunked radio system.

A mobile unit may communicate directly to other mobile units by operating in direct mode. In direct mode, the mobile units communicate over a fixed radio channel and there is no system controller allocating resources. Any direct mode mobile unit that has the capability to communicate over the fixed channel simply does so when it desires to transmit or receive. There is no registration process required for a direct mode mobile station to communicate with another direct mode mobile station.

U.S. Patent No. 4,553,262 provides a communications system that enables a radio unit operating in direct mode to communicate to a trunked radio system. However, there exists a need for a direct mode mobile station to be able to register with the system controller of a trunked radio communications system. Additionally, there exists a need for a method of registering a direct mode mobile station with a system controller of any communications system.

Summary of the Invention

According to a first aspect of the present invention, there is provided a method for registering a direct mode mobile station with a system controller of a trunked radio system by an independent gateway transceiver. The method includes registering the mobile station with the system controller of the trunked radio system by the gateway transceiver.

In a preferred embodiment, the method includes transmitting a third party registration demand from the gateway transceiver to the system controller to demand registration of the mobile station.

Brief Description of the Drawing

FIG. 1 shows a coverage area for a trunked radio communications system.

FIG. 2 shows a coverage area for a direct mode mobile station according to the present invention.

FIG. 3 shows a sequence of messages for registration of a mobile station according to the present invention.

FIG. 4 shows a direct mode mobile station originated termination sequence for the method of FIG. 3.

FIG. 5 shows a gateway transceiver originated termination sequence for the method of FIG. 3.

FIG. 6 shows a system controller originated termination sequence for the method of FIG. 3.

Detailed Description of the Preferred Embodiment

FIG. 1 shows a coverage area 10 for a trunked radio communications system including a base station 11 and a gateway transceiver 14 within the coverage area and a direct mode mobile 16 outside of the coverage area 10. A gateway transceiver is a radio unit that is able to operate both on the trunked radio communications system and in direct mode.

The base station of a trunked radio communications system includes a system controller 12. The system controller 12 controls the registration of mobile stations and the allocation of communications resources of the communications system. The trunked radio communication system may be of any type known in the art.

The direct mode mobile station 16 is a mobile station operating in a direct mode. The direct mode mobile station 16 is able to communicate directly to another mobile station or gateway transceiver over a fixed or single channel. The direct mode may be a selective mode of operation for a trunked mobile station whereby the mobile station may

communicate directly with another mobile station without going through the system controller 12 of the trunked radio system. The coverage area 18 of a direct mode mobile unit 16 is usually much smaller than the coverage area of a trunked radio communications system 10.

FIG. 2 shows the direct mode mobile station communicating directly to a gateway transceiver 14 thereby communicating to the system controller 12 of the trunked radio communications system. The direct mode mobile station 16 communicates over a fixed radio channel to the gateway transceiver 14. The gateway transceiver 14 then communicates to the system controller 12 over a trunked radio channel. The direct mode mobile station 16 may register with the system controller 12 of the communications system via the gateway transceiver 14 using a third party registration scheme. The third party registration scheme will inform the system controller 12 that the direct mode mobile station 16 may be contacted by the gateway transceiver 14.

FIG. 3 shows a method of registering a direct mode mobile station with a system controller of a trunked radio communications system. The method is shown best as a sequence of steps flowing between a direct mode mobile station 16, a gateway transceiver 14, and a system controller 12.

In a preferred embodiment, the direct mode mobile station 16 transmits a gateway transceiver search message 20 to at least one gateway transceiver 14 in order to find an available gateway transceiver to register the mobile station with the system controller 12 of the trunked radio system. The gateway transceiver search message invites any capable gateway transceiver to act as a gateway transceiver for the direct mode mobile station 16. The gateway transceiver search message contains a message identification, an address of the direct mode mobile station 16, and, optionally, authentication information to authenticate the gateway transceiver 14 as a valid gateway transceiver. Alternatively to searching for any capable gateway transceiver, the mobile station 16 may search for a specific gateway transceiver by including the individual address of the desired gateway transceiver. The direct mode mobile station 16 may also search for any group of gateway transceivers by including a group address in the gateway transceiver search message.

The gateway transceiver 14 receives the gateway transceiver search message and responds to the mobile station 16 by transmitting a gateway transceiver acknowledgement message 22 to the mobile station 16. The gateway transceiver acknowledgement message indicates to the mobile station 16 that the gateway transceiver 14 is available to communicate to the system controller 12 of the trunked radio system for the mobile station 16.

The gateway transceiver acknowledgement message contains a message identification, the address of the gateway transceiver 14, the address of the direct mode mobile station 16 and, optionally, the gateway transceiver authentication information. The gateway transceiver authentication information authenticates the gateway transceiver 14 as a proper gateway transceiver for the mobile station 16. Thus, a level of security may be imposed on the communications system.

In the case where the gateway transceiver 14 acts as a dedicated gateway transceiver for the mobile station 16, the information field that represents the address of the gateway transceiver 14 may be the same address as the mobile station 16.

When a mobile station 16 receives a gateway transceiver acknowledgement message from the gateway transceiver 14, with the correct authentication information, the mobile station 16 may decide whether to accept the gateway transceiver 14 as a via for communication with the trunked radio communications system. If the mobile station 16 is satisfied that the gateway transceiver 14 is a suitable gateway transceiver then the mobile station 16 transmits a gateway transceiver confirm message 24.

When the gateway transceiver 14 receives a gateway transceiver confirm message, the gateway transceiver 14 transmits a third party registration demand message 26 to the system controller 12. The third party registration demand message informs the system controller 12 that the mobile station 16 may only be accessed via the gateway transceiver 14 and therefore the performances that can be achieved by the mobile station 16 are not the same as if the mobile station 16 were in direct contact with the system controller 12. For example, the call set up time to the mobile station 16 must be extended because the information exchange must travel across a direct mode air interface in addition to a trunked air interface. Also the end to end delay of any trunked mode service involving the mobile station 16 in combination with the gateway transceiver 14 will be longer than normal. In addition, the capability of the gateway transceiver 14 may restrict the communication capability of the mobile station 16, such as a limitation to the maximum data throughput to or from the mobile station 16 via the gateway transceiver 14, or the loss of duplex capability, or the loss of an entire service such as packet data which may not be supported by direct mode. In such circumstances, it is imperative that the system controller 12 is aware of the capability of the mobile station 16 in combination with the gateway transceiver 14.

Furthermore, it is important for the system controller 12 to know that there is an association between the gateway transceiver 14 and the mobile

station 16 because if the gateway transceiver 14 is supporting a communication with the trunked radio system for the mobile station 16 then the gateway transceiver 14 may not manage to support a trunked mode call for itself. Additionally, the system controller 12 also must be made aware when the gateway transceiver 14 has a reduced capability for exchange of control information.

Upon receipt of a third party registration demand, the base station, if necessary, authenticates both the gateway transceiver 14 and the mobile station 16 by issuing a third party authentication demand message 28. The gateway transceiver 14 performs its own authentication duties and passes authentication request 30 to the mobile station 16. The mobile station 16 performs its authentication duties and passes a reply 32 to the gateway transceiver 14. The gateway transceiver 14 finally passes a combined authentication response 34 to the system controller 12 using a third party authentication reply message. Thus, every gateway transceiver 14 and mobile station 16 operating via a gateway transceiver 14 on the system may be authenticated.

Upon completion of the authentication process, the system controller 12 transmits a third party registration reply message 36 to the gateway transceiver 14 indicating whether or not registration was successful. The gateway transceiver 14 then indicates the registration status by transmitting a gateway transceiver registration message 38.

Having successfully completed the gateway transceiver and mobile station message exchange sequence as described above, the mobile station 16 is effectively registered with the system controller 12 of the trunked radio communications system. The gateway transceiver 14 is also now empowered to pass information from the mobile station 16 to the system controller 12 and from the system controller 12 to the mobile station 16 using the address of the mobile station 16 when communicating on behalf of the mobile station 16.

The gateway transceiver and mobile station arrangement may be terminated by any of the three equipments, system controller 12, gateway transceiver 14 or mobile station 16. Once the gateway transceiver and mobile station arrangement has been dissolved, the gateway transceiver 14 is no longer empowered to act on messages addressed to the mobile station 16.

FIG. 4 shows a termination sequence for a direct mode mobile originated termination. When the direct mode mobile station 16 elects to terminate its gateway transceiver arrangement the direct mode mobile station 16 transmits a terminate message 42 to the gateway transceiver 14. The gateway transceiver 14 then transmits a terminate acknowledgement message 44 to the direct mode mobile sta-

tion 16. The gateway transceiver 14 then must transmit a third party de-register demand 46 to the system controller 12 to instruct the system controller 12 to de-register the direct mode mobile station 16. The system controller 12 transmits a third party de-register reply 48 to the gateway transceiver 14 and the mobile station 16 is thereafter no longer registered with the system controller 12. If the mobile station 16 subsequently wishes to communicate on the trunking system, the mobile station 16 must re-register with the system controller 12.

It is interesting to note that when the mobile station 16 terminates the gateway transceiver and mobile unit arrangement, it may be because the mobile station 16 is able to communicate directly with the system controller 12 and can register directly with the system controller 12 using the normal registration process.

FIG. 5 shows a termination sequence for a gateway transceiver 14 originated termination. The gateway transceiver 14 transmits a third party de-registration demand 52 to the system controller 12. The system controller 12 then transmits a third party de-registration reply 54 to the gateway transceiver 14 and de-registers the direct mode mobile station 16 from the system. The gateway transceiver 14 then transmits a detach message 56 to the mobile station 16 to inform the mobile station of the de-registration. The mobile station 16 then transmits a detach acknowledge message 58 to the gateway transceiver 14 acknowledging that the mobile station 16 and gateway transceiver arrangement has been terminated.

FIG. 6 shows a termination sequence for a system controller 12 originated termination. The system controller 12 transmits a third party de-registration demand 62 to the gateway transceiver 14 to inform the gateway transceiver 14 that the system controller 12 is de-registering the direct mode mobile station 16 from the trunking system. The gateway transceiver 14 replies with a third party de-registration reply 64 to the system controller 12 acknowledging the de-registration of the direct mode mobile station 16. The gateway transceiver 14 then transmits a detach message 66 to the mobile station 16 informing the mobile station 16 that it is no longer registered on the system. The mobile station 16 replies with a detach acknowledgement message 68 to the gateway transceiver 14 acknowledging that the mobile station and gateway transceiver arrangement has been terminated.

The general scheme may in principle be used to chain more than one gateway transceiver. If this were to be attempted, then the achievable temporal quality of service performances may be adversely affected because of the extra delay involved.

The method of the present invention may be used to extend the coverage range of a system

controller 12 for a trunked radio communications system. For example, if a trunked mobile station is outside of the coverage area of the trunked radio communications system the mobile station may communicate to the trunked radio communications system by first communicating using direct mode to a gateway transceiver within the coverage area and having the gateway transceiver communicate to the trunked radio communications system. The gateway transceiver must be in close proximity to the direct mode mobile and also in the coverage area of the trunked radio communications system. The gateway transceiver 14 communicates to the trunked radio communications system for the direct mode mobile station 16 whereby the direct mode mobile station 16 may register with the system controller 12 of the trunked radio communications system. Thus, the present invention provides a method for registering a direct mode mobile station with a trunked radio system by an independent gateway transceiver using a third party registration scheme.

Claims

1. A method for registering a direct mode mobile station with a system controller of a trunked radio system by an independent gateway transceiver comprising the step of:
 - selecting an available gateway transceiver by the direct mode mobile station; and
 - registering the mobile station with the system controller of the trunked radio system by the gateway transceiver using a third party registration scheme.
2. The method of claim 1 wherein the step of selecting comprises the steps of:
 - searching for an available gateway transceiver to register the mobile station with the system controller of the trunked radio system; and
 - acknowledging from an available gateway transceiver to the mobile station that the gateway transceiver is available to register the direct mode mobile station with the system controller of the trunked radio system.
3. The method of claim 2 wherein the step of searching for an available gateway transceiver comprises the step of:
 - transmitting a gateway transceiver search message from the mobile station to at least one gateway transceiver in an attempt to find an available gateway transceiver to register the direct mode mobile station with the system controller of the trunked radio system.
4. The method of claim 3 wherein the step of transmitting the gateway transceiver search message includes transmitting an address of the mobile and an address of the gateway transceiver.
5. The method of claim 2 wherein the step of acknowledging comprises the step of:
 - transmitting a gateway transceiver acknowledgement message from a gateway transceiver; and
 - receiving a gateway transceiver acknowledgement message at the mobile station from the gateway transceiver indicating status of the gateway transceiver.
6. The method of claim 5 wherein the step of acknowledging further comprises the step of:
 - transmitting a confirmation message from the mobile station to the gateway transceiver to indicate to the gateway transceiver to transmit a registration message to the system controller.
7. The method of any preceding claim wherein the step of registering the mobile station with the system controller of the trunked radio system by the gateway transceiver comprises the steps of:
 - transmitting a third party registration demand from the gateway transceiver to the system controller to demand registration of the mobile station;
 - transmitting a registration reply from the system controller to the gateway transceiver; and
 - transmitting a registration status by the gateway transceiver to the mobile station thereby confirming registration of the mobile station with the system controller of the trunked radio system by the gateway transceiver.
8. The method of any preceding claim wherein the step of registering the mobile station with the system controller of the trunked radio system by the gateway transceiver comprises the step of:
 - authenticating the mobile station by the system controller to verify if mobile station is a valid user.
9. The method of any preceding claim further comprising the step of terminating registration of the mobile station initiated by the gateway transceiver.
10. The method of claim 9 wherein the step of terminating registration of the mobile station

initiated by the gateway transceiver comprises the steps of:

transmitting a third party de-registration demand by the gateway transceiver to the system controller;

receiving a third party de-registration reply from the system controller at the gateway transceiver;

transmitting a gateway transceiver detach message from the gateway transceiver to the mobile station; and

receiving a detach acknowledgement by the mobile station at the gateway transceiver.

11. The method of any one of claims 1 to 8 further comprising the step of terminating the registration of the mobile station initiated by the mobile station.

12. The method of claim 11 wherein the step of terminating registration of the mobile station initiated by the mobile station comprises the steps of:

receiving a terminate message at the gateway transceiver from the mobile station;

transmitting a termination acknowledgement message from the gateway transceiver to the mobile station;

transmitting a third party de-registration demand from the gateway transceiver to the system controller; and

transmitting a third party de-registration reply from the system controller to the gateway transceiver.

13. The method of claim 1 to 8 further comprising the step of terminating the registration of the mobile station initiated by the system controller.

14. The method of claim 13 wherein the step of terminating the registration of the mobile station initiated by the system controller comprises the steps of:

receiving a third party de-registration demand from the system controller at the gateway transceiver;

transmitting a third party de-registration reply message from the gateway transceiver to the system controller;

transmitting a gateway transceiver detach message from the gateway transceiver to the mobile station; and

receiving a detach acknowledge at the gateway transceiver from the mobile station.

15. A method for registering a direct mode mobile station with a system controller of a trunked

radio system by an independent gateway transceiver substantially as herein described with reference to FIG. 3 of the drawing.

FIG. 1

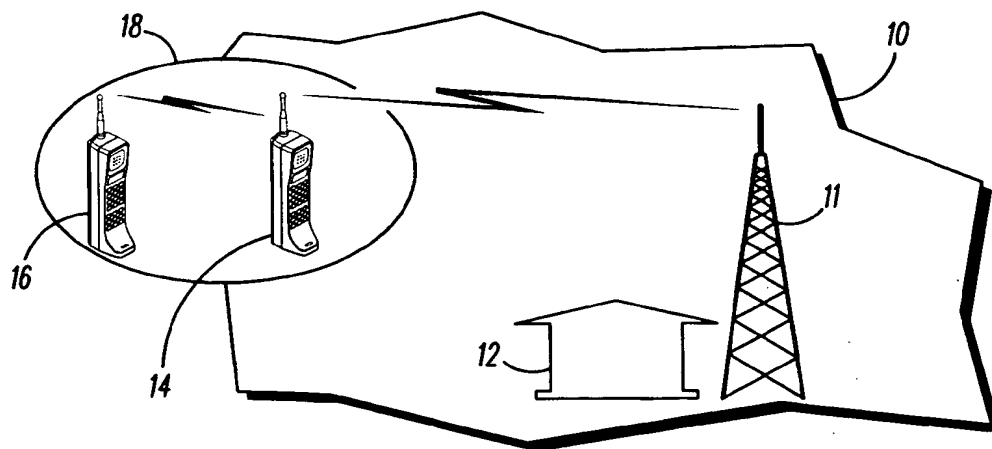
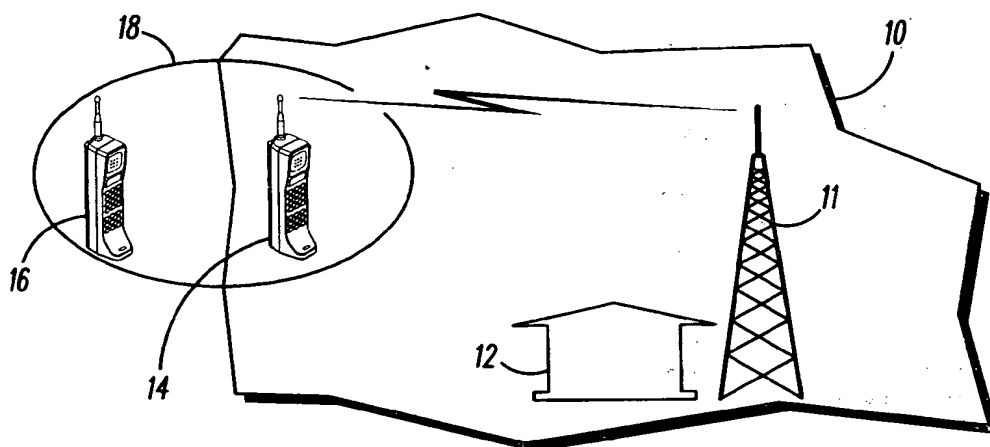


FIG. 2

FIG. 3

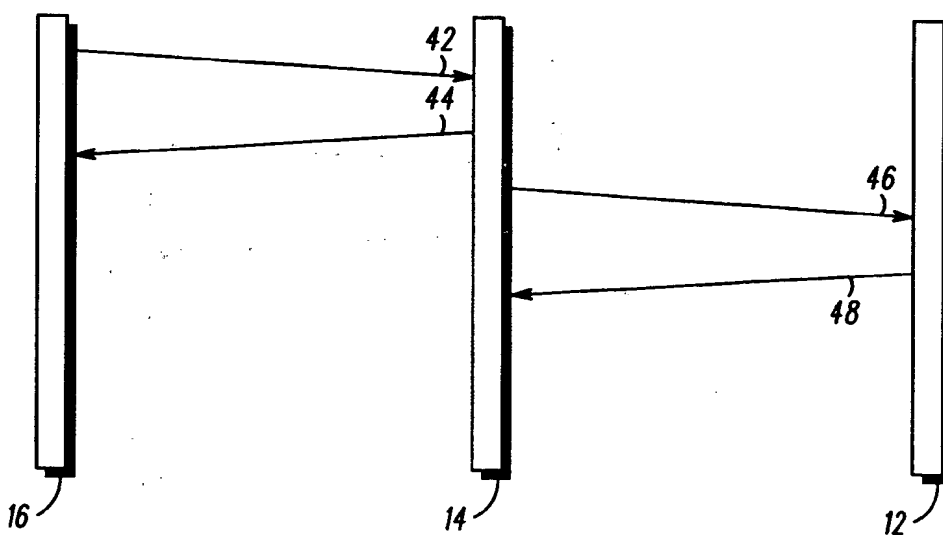
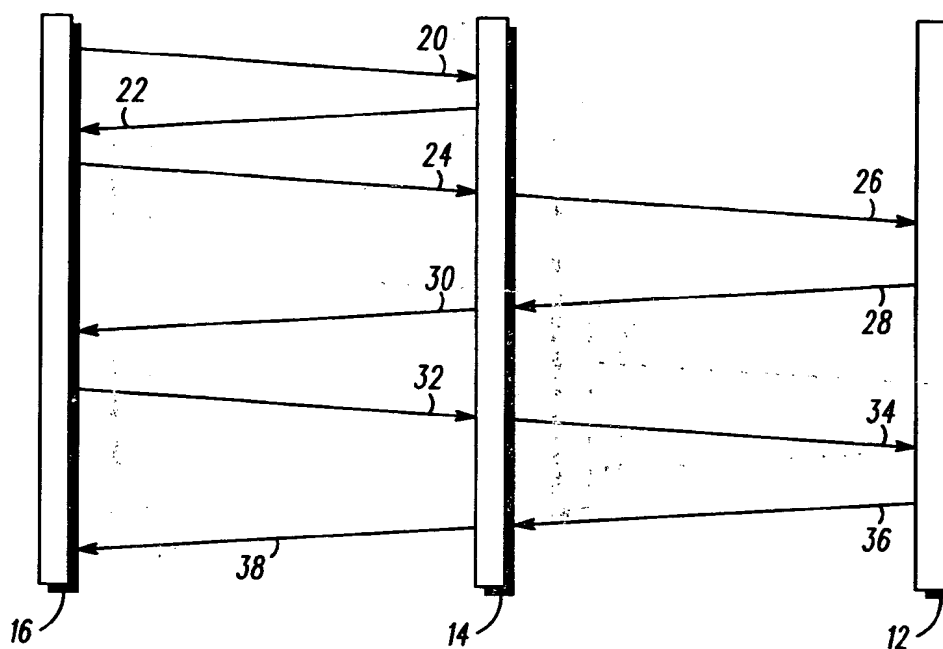


FIG. 4

FIG. 5

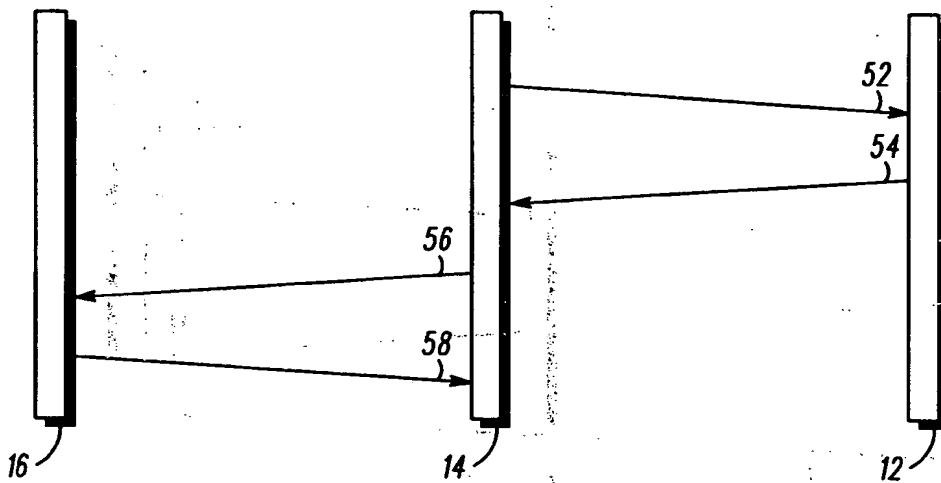
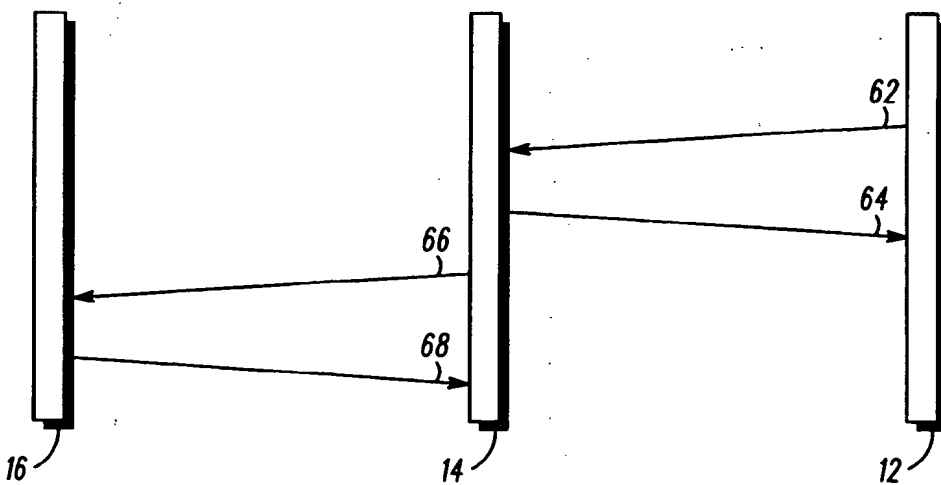
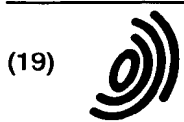


FIG. 6



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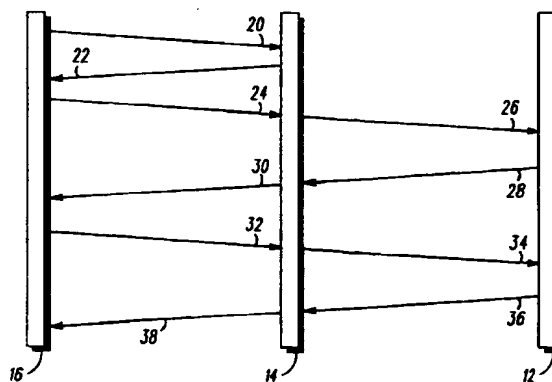
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(54) **Method for registering direct mode mobile stations in a trunking communications system**

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FIG. 3



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EUROPEAN SEARCH REPORT

Application Number
EP 95 10 0342

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			H04Q
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 9 June 1999	Examiner Janyszek, J-M
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1. The present invention relates to a method of
2. determining the concentration of a substance in a
3. sample, and more particularly to a method of
4. determining the concentration of a substance in a
5. sample by measuring the absorbance of the sample
6. at a specific wavelength. The method of the
7. present invention is particularly useful for the
8. determination of the concentration of a substance
9. in a sample which is a mixture of two or more
10. substances. The method of the present invention
11. is based on the principle that the absorbance of
12. a substance in a sample is directly proportional
13. to the concentration of the substance in the
14. sample. The method of the present invention
15. involves the measurement of the absorbance of the
16. sample at a specific wavelength, and the
17. determination of the concentration of the
18. substance in the sample by comparing the
19. measured absorbance with the absorbance of a
20. standard solution of the substance.

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